

# How Integrated Land Use Affects Seasonal and Spatial Soil Moisture in the Brazilian Cerrado Biome

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## Introduction

The Cerrado biome has seen and is still experiencing increasing agricultural encroachment. However, deforestation and replacement of the natural savannah vegetation by cropland and pasture has contributed to serious environmental problems, including soil degradation and altered water cycles. Compared to conventional pasture or cropping systems, the introduction of trees via integrated land use raises the question if these systems hold potential to improve or maintain soil health and water-related processes and thus function more like the natural Cerrado in regard to soil moisture (SM) dynamics and water cycles. Our study focuses on SM dynamics measured until 100 cm depth for continuous pasture (COP), integrated crop livestock (ICL), integrated crop livestock forestry (ICLF) systems and natural Cerrado (CER) on a long-term EMBRAPA monitoring site.

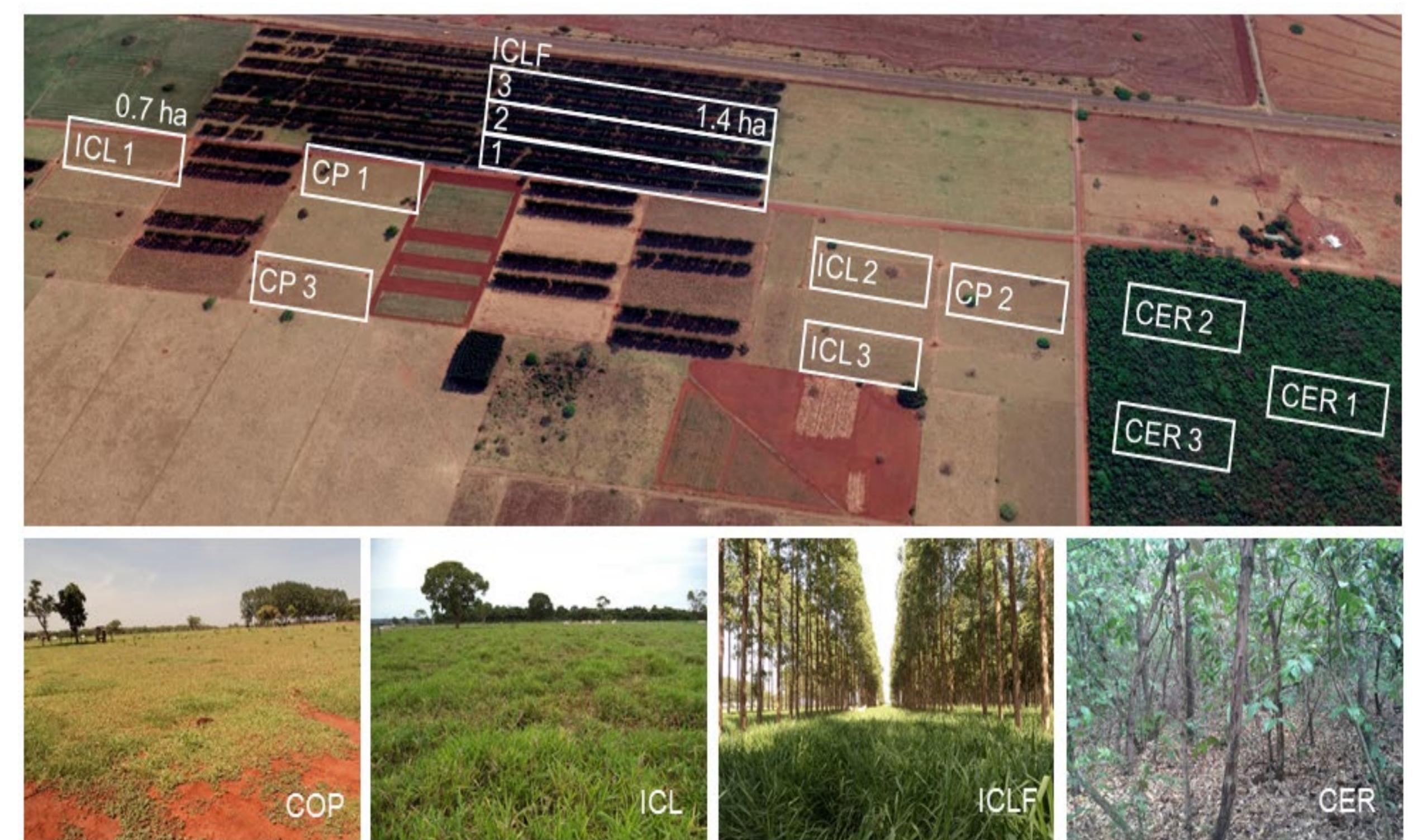


Fig 1: The top image is map of the study area, indicating the location of the four different treatments, whose images are below: continuous pastures (COP); integrated crop-livestock system (ICL); integrated-crop-livestock-forestry system (ICLF); Cerrado (CER).

## Results and Discussion

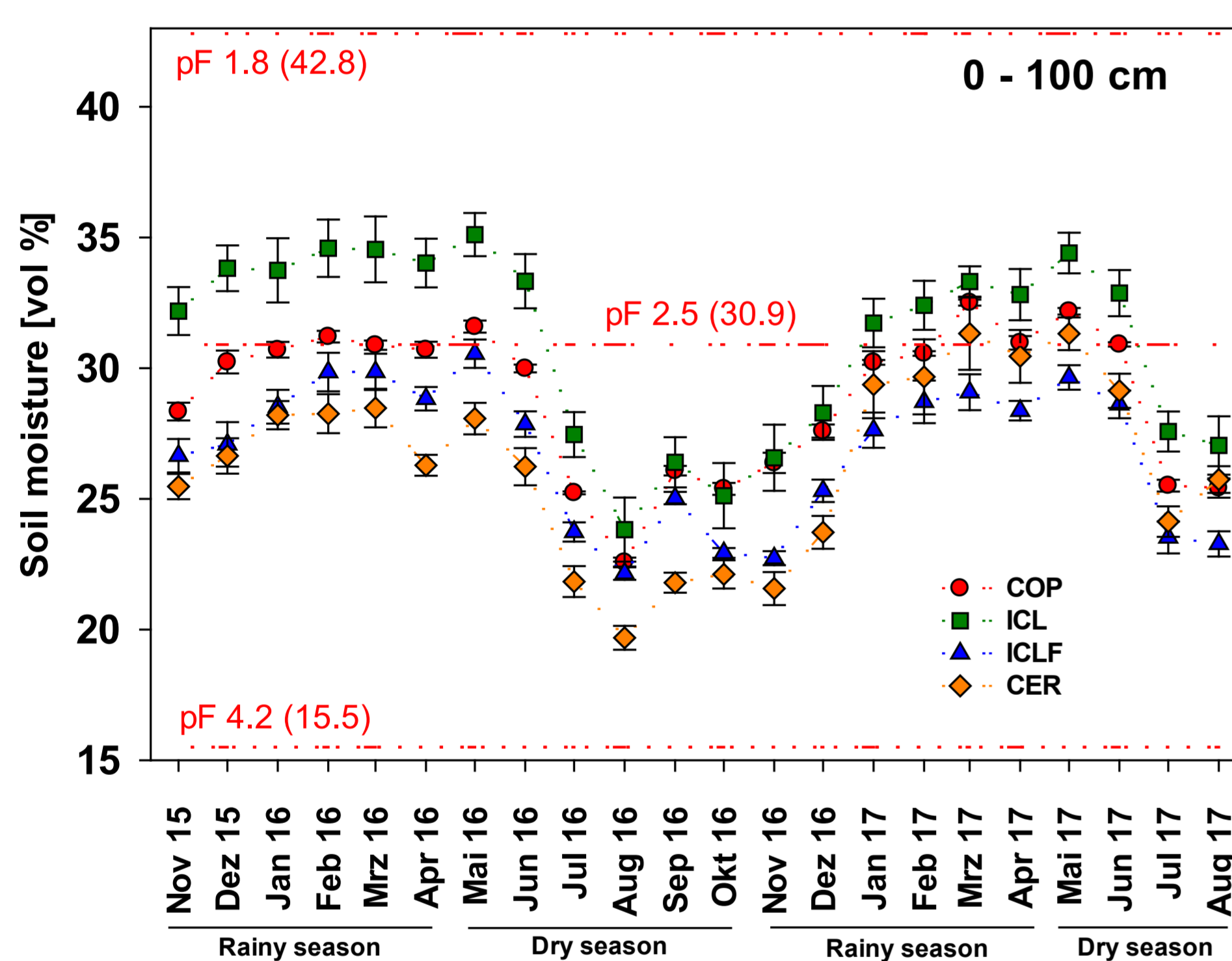


Fig 2: Monthly mean SM over 0 - 100 cm soil depth.

- SM changes in all treatments were strongly seasonal with high SM in the rainy season (RS) and lower SM in the dry season (DS) in response to the rainfall regime.
- For both seasons, pooled over 1 m depth, SM was always lower in the treatments with trees, ICLF and CER, as compared to treatments without trees, COP and ICL.
- ▶ Due to the different rooting patterns, trees and shrubs often access deeper soil layers, resulting in increased water uptake and transpiration.

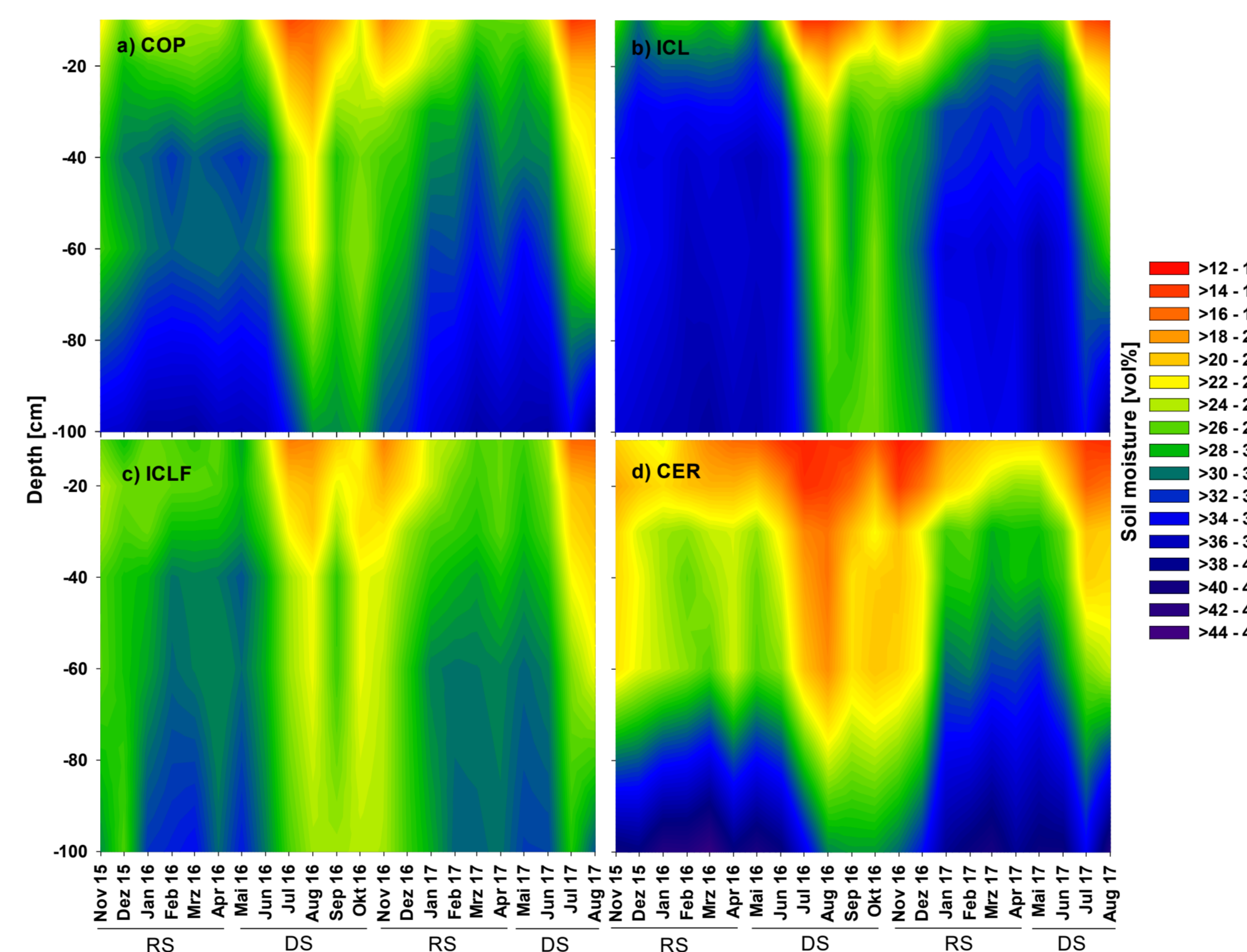


Fig 3: Monthly mean SM between 10 - 100 cm soil depth.

- In general SM was lowest in the topsoil (0 – 30 cm) and increased with depth.
- COP and ICL water was mainly taken up from the topsoil ▶ Main rooting zone of the pasture.
- Subsoil was on average lowest in ICLF and differences between subsoil SM between ICLF and CER were strongly seasonal.
- Topsoil was driest in CER throughout the seasons and conserved below 60 cm depth ▶ Most likely, due to lower water retention related to very high macroporosity.

## Conclusion

- ❖ Generally, SM lower in treatments with trees ▶ higher ET
- ❖ Higher AGBM production in integrated systems (ICL and ICLF) ▶ not related to water availability but rather to soil characteristics.
- ❖ In general, integrated systems offer a good alternative to traditional pastures in terms of soil quality and productivity.
- ❖ Trees introduced to land-use systems may counterbalance reduced ET after Cerrado deforestation and thus help to restore natural ecosystem function regarding water recycling into the atmosphere.

Tab 1: Bulk density (BD), soil organic carbon (SOC), and aboveground biomass (AGBM) of the four different treatments.

	BD [g cm <sup>-3</sup> ]	SOC [%]	AGBM [g DW m <sup>-2</sup> ]
COP	1.27	1.40	206*
ICL	1.18	1.74	760*
ICLF	1.15	1.49	606**
CER	0.98	2.12	898***

\*green + dead grass AGBM, \*\*green + dead + litter AGBM, \*\*\*only litter

## Materials and Methods

In cooperation with EMBRAPA Beef Cattle, we conducted a field measurement campaign from Nov 2015 to Aug 2017, Campo Grande MS, on a long-term experimental site. Soil Moisture (SM, DELTA T FDR) and aboveground biomass (AGBM, moving cages) measurements were performed in four land-use systems, defined here as treatments, namely: continuous pastures (COP), integrated crop-livestock system (ICL), integrated-crop-livestock-forestry system (ICLF), and natural savannah vegetation, Cerrado (CER). The soil of the study area is classified as a Ferralsol. The study area is characterised by a tropical savannah Aw climate with a mean annual temperature of 22.6°C and mean annual rainfall of 1560 mm. There is a distinct rainy season from November to April and a dry season from May to October.